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(54) FEEDING CONTINUOUS PLIABLE MATERIAL OF VARIABLE
 ELASTIC MODULUS

- (71) We, MASCHINENFABRIK GOEBEL G.m.b.H., a German company, of 61 Darmstadt, Goebelstrasse 21, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- The invention relates to apparatus for feeding continuous pliable material, of variable elastic modulus, with a constant elongation. The material may be, for example, webs made of paper, foil, tissue, metal, plastics or the like or of thread-like materials.
- With apparatus of this type, a web or a thread-like material may be pulled off a reel or the like and fed to a subsequent handling machine. This machine may be e.g. a printing machine, a slitting machine, or a winding machine. As a rule, in these machines, the material being unwound from the reel is submitted to a load in order that a tension develops in the material and this material is fed in tensioned condition passing through the handling machine. To this effect, the reel carrying the material is usually connected to a brake. Through the effect of this brake there arises a tension in the material; due to this tension and the effect of the Hooke's Law, there arises, furthermore, a yield or elongation which very often shows undesired results.
- For example, the material from the reel may be fed through the subsequent handling machine at a determined tension and at a certain yield, at the same time as it is being printed and then cut into sheets. After having been cut off, these sheets are set free from their inherent tension and, as a result thereof, they do contract. Hence, as a rule, the finished sheets show another length as compared with the corresponding portion of the web still running through the printing machine to be printed. Another example is the subsequent handling of the webs printed in a printing machine. For example, it may be necessary that the holes which have been perforated or punched into the webs keep a certain distance from each other when the webs are in a relaxed condition. If this distance is not maintained exact enough, difficulties will arise during a subsequent treatment of the webs. Such difficulties will occur especially when webs of different materials, e.g. webs of several paper qualities, shall be handled simultaneously. This is the case, for example, if all of the holes which have been punched by the same punching tool simultaneously into various webs shall show equal distances from each other in the relaxed condition of the webs.
- Similar problems arise in connection with length measuring of threads, wires or the like, or in such cases where wires are to be provided with an insulation, a braiding or the like.
- These difficulties will arise especially in those cases where the web of the thread-like material over its full length has different elastic modulus due to manufacture or handling procedures as e.g. winding operations as is often the case with plastics foils for example.
- These materials very often have no well-defined elastic modulus and, therefore are said to have so-called complex elastic modulus where it is rather difficult to apply the Hooke's Law.
- In order to overcome these difficulties, a regulating device has been proposed as disclosed in the unexamined German Patent Application (OS) 22 56 882, which is connected to devices for measuring the web tension and the web speeds. On the basis of these measurements, a computer establishes an actual value which is compared with the nominal value.
- Hence, there remains the task to develop a simple apparatus, reliable in operation, with the help of which it is possible to feed continuous pliable material, of variable elastic modulus, with a constant elongation.
- In accordance with the invention there is provided apparatus for feeding continuous pliable material, of variable elastic modulus, with a constant elongation, comprising first and second tensioning devices respectively arranged in upstream and downstream por-

tions of the path of the continuous pliable material and means for controlling the two tensioning devices so that as the tensions imposed on the continuous pliable material by the two tensioning devices vary, the ratio of these tensions remains constant.

The apparatus according to the invention avoids expensive and often troublesome electronics; it is simple in design and construction, and reliable in operation. It eliminates any web speed measuring devices. By the method of operation of the apparatus no inaccuracies will occur due to measuring faults or the like. Furthermore, there is no need to put marks onto the material being handled which thus eliminates the risk for the material to be marred at any point by such a marking. In connection with a suitable register control device, the apparatus also opens up new ways of use in connection with a printing machine.

Embodiments of the invention are herein-after described, by way of example, with reference to the accompanying schematic drawings in which unessential parts of the machine are omitted for the sake of clarity, and in which:—

Figure 1 is a side elevation of one embodiment of the apparatus;

Figure 2 is a sectional view substantially on the line II—II of Figure 1; and

Figure 3 is a side elevation of a second embodiment of the apparatus.

The continuous pliable material to be handled, for example a web 1 made of paper, plastics, tissue or the like, is unwound from a stock reel 2. This stock reel is rotatably mounted in suitable bearings, known to the expert and therefore not described in detail secured in the frame of the apparatus. In this frame also most of the other rollers of the apparatus are rotatably mounted by means of bearings. A braking disk 3 is rotationally connected to the stock reel 2 with the aid of suitable means. A braking mechanism 4 cooperates with this brake disk 3. Said braking mechanism comprises brake jaws 5 and 6 which engage with the brake disk, as well as a corresponding kinematic gearing which comprises the operating bar 7.

In the frame, furthermore, guide rollers 8, 9, 10 and 11 are rotatably mounted. In addition, a first web feeding device comprising the rollers 12 and 13 is rotatably attached in the frame; roller 13 is driven. A second web feeding device consists of the rollers 14 and 15, of which roller 15 is driven. In the frame there is also a first fixed pivot 16 and a second fixed pivot 17. These pivots 16 and 17 may consist of one shaft each, for example shaft 18 and shaft 19. Both of the two shafts 18 and 19 are rotatably carried in suitable bearings in the frame of the machine, these bearings being

indicated by 20, 21, 22, and 23. Support arms 24 and 25 are firmly connected to the shaft 18 and a floating roller 26 is rotatably attached to the arms. Thus, each oscillating movement of the floating roller 26 causes a rotation of the shaft 18 and therewith also a swiveling movement of a support arm 27, which also is firmly connected to the shaft 18. A displaceable weight 28 is attached to this arm 27. This weight loads the roller 26 and thus by means of the roller tension forces are introduced into the web, the thread or the like, i.e. to the material to be handled.

Analogously support arms 29 and 30 are firmly connected to a shaft 19. To shaft 19 there is furthermore firmly connected a support arm 31 to which a second displaceable weight 32 is attached. In addition, a floating roller 33 is rotatably attached to the holding arms 29 and 30. There is thus provided a second device by means of which tension forces are introduced into the web being handled.

Furthermore, a spur gear 34 is freely mounted for rotation about the shaft 18. This spur gear 34 is firmly connected to a bevel gear 35 which is also freely rotatable relative to the shaft 18. The bevel gear 35 coacts with another bevel gear 36 which latter is connected to a spindle 37. This spindle 37, on its part, is connected to the weight 28 by means of a nut or the like, in such a manner that a rotational movement of the spindle 37 effects a displacement of the weight 28 along the arm 27.

Analogously a spur gear 38 is freely mounted for rotation about the shaft 19. Said spur gear is firmly connected to a bevel gear 39 which is also freely rotatable relative to the shaft 19, the gear 39 coacting with another bevel gear 40 which is connected to a spindle 41. Said spindle 41, on its part, is connected to the weight 32 by means of a nut, for example, in such a manner that a rotational movement of the spindle 41 provokes a displacement of the weight 32 along the arm 31.

Another spur gear 42 is in mesh with the spur gears 34 and 38. Said spur gear 42 is rotatably mounted by means of a shaft 43 supported by bearings. To this shaft a motor 44 is operatively connected.

The weights 28 and 32 are of different sizes so that their masses are in a certain desired ratio. The gears 34 and 38 have the same number of teeth. In this manner, and because the gear 42 is in mesh with the gear 34 as well as with the gear 38, it is ensured that the motor 44, with the help of said gears, is able to displace the weights 28 and 32 in such a way that the torques produced by the weights 28 and 32 on the shafts 18 and 19—remain at an unvaried, constant ratio in any position of the weights 28 and

32. It is furthermore possible to coordinate either the gear ratio of the spindles 37 and 41 only, or the gear ratio of the spindles 37 and 41 and also the ratio of the gears 34—36, 38—40, and 42, with equal weights, in such a way that there result different loads at the rollers 26 and 33, acting on the material being handled.

As a result of the fact that the center-to-center distances between the pivot 16 and the floating roller 26, as well as between the pivot 17 and the floating roller 33 are equal to each other, forces act on the rollers 26 and 33 which, are of the same ratio relative to each other as is the ratio of the weights 28 and 32. The ratio of these forces, and thus that of the forces exerted on the webs by the floating rollers, remains constant in each position of the weights.

A bevel gear 45 is connected to the roller 13 of the first feeding device for rotation of the roller 13. This bevel gear is connected to another bevel gear 46 which is connected to a shaft 47. This shaft 47 is connected by bevel gears 48 and 49 to a shaft 50.

Analogously the roller 15 of the second feeding device is firmly connected to a bevel gear 5 which latter coacts with a bevel gear 52 connected to a shaft 53. The shaft 53 is connected to a shaft 56 through bevel gears 54 and 55.

The shaft 56 receives a constant speed drive which is picked-off from a driving source in the apparatus, not shown. Between the shafts 56 and 50 there is a variable ratio gearing 57, the ratio of which can be varied by means of a shaft 58 driven by a motor 62. This gearing may be either positive or non-positive locking. Furthermore, the gear ratio should remain constant irrespective of the forces acting thereupon.

With the shaft 19 there is furthermore connected a device with the aid of which it is possible to vary the ratio of the gearing 57 in such a way that a turn of the shaft 19 corresponds to a determined modification of the gear ratio. For example: the shaft 19 is firmly connected to a cam 59. Near this cam 59 there is a switch 60 stationarily fixed in the frame. The tappet 61 of this switch 60 follows the cam 59 and is able to close the switch 60 in such a way that the motor 62 rotates the shaft 58 of the gearing 57 in functional relationship with the rotational movement of the shaft 19, and thus with the position of the floating roller 33. This causes—because of the modified position of the floating roller 33—a change of the quantity fed at the feeding device consisting of the rollers 12 and 13. However, instead of a switch and a motor at the shaft 58, there may be alternatively provided a mechanical connection between the shaft 19 and the shaft 58, e.g. with the aid of a chain

drive or the like. The switch 60 is in any case connected to the motor 44.

The shaft 18 is furthermore firmly connected to a lever 63. This lever 63 is connected to the brake-operating bar 7. This means that the brake adjustment changes if the position of the floating roller 26 has changed.

The operation of the apparatus is as follows:

If in the web 1, running into the apparatus, there is a portion with a different elastic modulus as may occur for example in case of a change of the E-modulus owing to differences in quality of the material within the web or, alternatively, after the exchange of stock reels 2, there occurs a change in the yield of the web 1 because of the still unchanged loading by the floating roller 26 and the weight 28 so that the first feeding device consisting of the rollers 12 and 13 feeds a different length of material (measured in relaxed condition). After having left the feeding device consisting of the rollers 12 and 13, the said portion of the web 1—under the load exerted by the floating roller 33 and the weight 32—is put into a degree of yield which is different as compared with the degree of yield prior to the change of the E-modulus and which differs from the degree of yield under the load exerted by the floating roller 26 and the weight 28; this requires a modified and hereto adapted feed capacity of the feeding device comprising the rollers 12 and 13. The behaviour of this feeding device through the gearing 57 not yet having been adapted to the modified E-modulus of the incoming web, the floating roller 33, by changing its position, counter-balances the different quantities being transported at this time by the pairs of feeding rollers 12/13 and 14/15. The ratio of the gearing 57 is thereby modified through the device being connected to the shaft 19, whereas the position of the weights 28 and 32 is modified by the motor 44 which is actuated by the cam 59 and the switch 60, and by the spindles 37 and 41 until the original yield has been re-established through the modified load on the web. The floating roller 33 thereby returns into the same position as it had before the regulating process has been introduced, whereby the feeding conditions of the feeding devices, consisting of the pairs of rollers 12/13 and 14/15, are adapted to the original yield of the web having now been re-established.

The proportion of the force exerted by the weight of the floating roller 26 and the additional weight 28 on the web 1, as compared with the force exerted by the weight of the floating roller 33 and the additional weight 32 on the web 1, is at any moment the same.

In the embodiment according to Fig. 3, the

weights 28 and 32 have been replaced by the fluid cylinders 64 and 65 so that the force-applying points of the fluid cylinders—
analogous to the centers of gravity of the weights—can be modified in such a manner
that the moments resulting from the actual load, and thus the forces exerted on the web, remain at a constant proportion relative to each other at any time and in any position.

The active forces exerted by each fluid cylinder behave in the same manner as do the weights according to the example in Fig. 1 and Fig. 2. This may be effected either by applying equal pressures on the cylinders 64 and 65 while the diameters of the fluid cylinders 64 and 65 show the indicated proportion relative to each other. But there is also the possibility that each fluid cylinder is loaded at a corresponding pressure which is effected by a suitable valve in the fluid supply line. This case permits equal diameters of the fluid cylinders. Each fluid cylinder is attached by a swivel joint 66 or 67 which is stationary in the frame of the apparatus. In this case, the joint connecting the specific cylinder or its piston to the corresponding holding arm of the floating roller, may be arranged at a fixed distance from the geometric axis of the shafts 18 or 19.

If different pressures are applied to the fluid cylinder 64 and to the fluid cylinder 65, it is obvious that also a suitable valve has to be provided which ensures an equal proportion of the two pressures to meet the requirements in that each one of the fluid cylinders has to apply forces on the floating rollers 26 and 33, and therewith on the processed web which remain at a constant and steady proportion relative to each other in any position of the floating rollers.

Though a web which has been described in the examples, the apparatus may be well be used for threads or wires. It is obvious that in such a case the described rollers have to be replaced by rolls or disks provided with a suitable profile which ensures that a thread- or wire-like material is reliably guided and loaded. In such a case, the floating rollers, too, would have to be replaced by corresponding rolls. Furthermore, it is possible to build the described second feeding device by means of rollers, rolls or the like already existing in the machine which subsequently handles the material, on the condition that these rollers, rolls or the like are rotating at the required accuracy. The apparatus, furthermore, provides also satisfactory results even if webs of different thicknesses are joined successively or if they are handled simultaneously.

Only two floating rollers have been mentioned with the embodiments described in detail. However, it is possible that—by increasing the amount of material—more

than two floating rollers may be provided which, however, would not mean a change of the scope of this invention.

During a constant run of the apparatus and with unvaried modulus of elasticity of web 1, the load exerted on web 1 by the floating roller 26 and the braking of reel 2 are in balance.

After a reduction of the modulus of elasticity, the web elongates as a result of the load exerted by the floating roller 26 and the weight 28, while the tension within web 1 remains unchanged, and less of the continuous pliable web—however at a more stretched condition—is being unwound from reel 2.

That portion of web 1 which shows a reduced modulus of elasticity passes thereafter by floating roller 33 where it is subjected again to a load exerted by the floating roller 33 and by the weight 32. Since weight 32 is different from weight 28, the load exerted on the web 1 by the floating roller 33 and the weight 32 is different as compared with the load exerted by the floating roller 26 and the weight 28. Hence, floating roller 33 will move, however, by another amount than did floating roller 26 at the moment when the same portion of web 1 passed by floating roller 26. Because of the different load exerted at floating roller 33, there result different elongations of web 1 within the portion between reel 2 and the feeding device consisting of rollers 12 and 13 on the one side, and the portion between the feeding device consisting of the rollers 12 and 13 and the feeding device consisting of the rollers 14 and 15, on the other side.

The web feed at the feeding devices 12/13 and 14/15, being balanced at the beginning, becomes disturbed because of the different loads exerted on web 1. The web 1—when passing by the floating rollers 26 and 33—is elongated through the weights 28 and 32. This elongation is at first compensated by a displacement of floating roller 33 which displacement provokes a movement of cam 58, and this in turn influences the switch 60.

Switch 60 engages at the same time the motor 44 as well as the motor 62, whereby the weights 28 and 32 are displaced through shaft 43, gears 42, 34, 38, 35, 39, 36, 40, and spindles 37 and 41. At the same time the gearing 57 is varied through the motor 62 and the shaft 58. This results in another rotational speed of shaft 50 and thus in another rotational speed of roller 13. Weights 28 and 32, as well as gearing 57 are modified all the time until the floating roller 33 takes again its initial position, and then only becomes the switch 60 disengaged. The weights 28 and 32 are now in a position where the web 1 is less loaded by them.

Any over-adjustment of the device results

in operation in the reverse sense so that the floating rollers 26 and 33 again move towards their original positions and this process is repeated until the floating rollers oscillate imperceptibly about their original positions.

On increase in the modulus of elasticity of the continuous pliable material, the devices operate in a completely analogous manner, but in the reverse sense.

WHAT WE CLAIM IS:—

1. Apparatus for feeding continuous pliable material, of variable elastic modulus, with a constant elongation comprising first and second tensioning devices respectively arranged in upstream and downstream portions of the path of the continuous pliable material and means for controlling the two tensioning devices so that as the tensions imposed on the continuous pliable material by the two tensioning devices vary, the ratio of these tensions remains constant.

2. Apparatus, according to Claim 1, in which adjustable retarding means are provided for varying the resistance of the continuous pliable material to movement, and the first tensioning device is connected to the adjustable retarding means.

3. Apparatus, according to Claim 1 or Claim 2, in which the second tensioning device is connected to a switch which is operable to vary the tensions imposed on the continuous pliable material by the two tensioning means.

4. Apparatus, according to any preceding claim, in which feeding means are arranged between the two tensioning means.

5. Apparatus, according to Claim 4, in which the second tensioning means are co-operable with speed control means for varying the rate of feed of the feeding means.

6. Apparatus, according to Claim 5 in which the speed control means comprise a variable ratio gear transmission.

7. Apparatus, according to any preceding claim, in which each of the first and second tensioning devices comprises a guide member which is supported, on opposite sides, by two pivotally mounted arms; a third pivotally mounted arm is mounted for

movement with the two pivotally mounted arms supporting the guide member; and loading means are provided for supplying a variable turning moment to the or each said third pivotally mounted arm.

8. Apparatus, according to Claim 7, in which the loading means of at least one of the first and second tensioning devices comprises a weight which is movable along the third pivotally mounted arm.

9. Apparatus, according to Claim 8, in which the or each said weight is movable by means of a rotatable, screw-threaded spindle.

10. Apparatus, according to Claim 8 or Claim 9, in which the or each said weight is movable by means of a motor and a gear train.

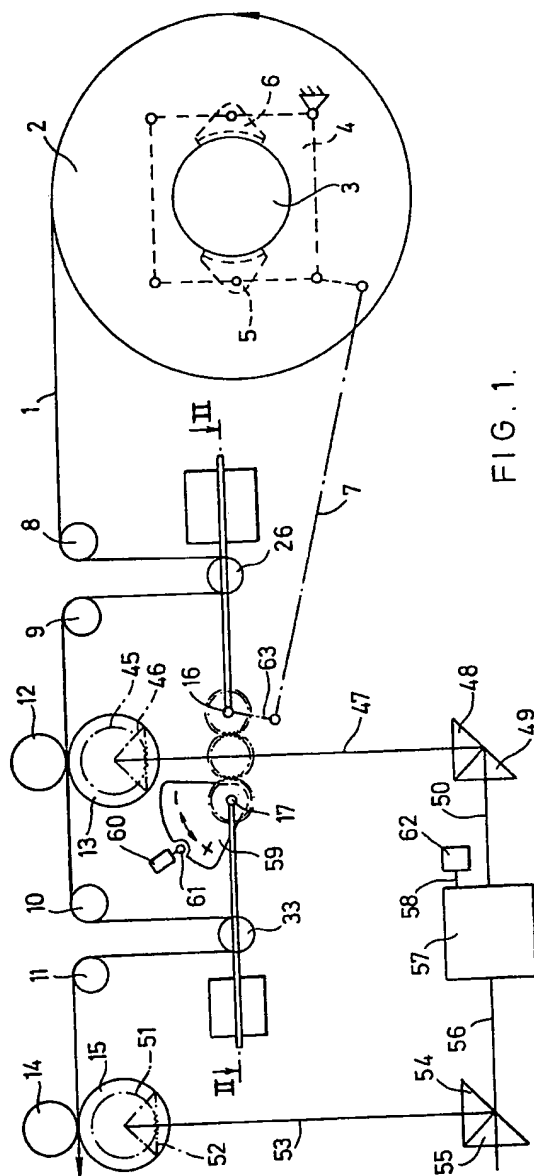
11. Apparatus, according to Claim 7, in which the loading means of at least one of the first and second tensioning devices comprises a fluid-driven, piston-cylinder assembly.

12. Apparatus, according to Claim 11, in which the loading means of both the first and second tensioning devices comprise fluid-driven piston-cylinder assemblies and control means are provided for ensuring that the pressures of fluid applied to the two piston-cylinder assemblies are maintained in the same ratio as the constant ratio of the tensions imposed on the continuous pliable material by the first and second tensioning means.

13. Apparatus, according to Claim 11, in which the loading means of both the first and second tensioning devices comprise fluid-driven, piston-cylinder assemblies and means for varying the points of application of loads imposed on the two third pivotally mounted arms by the two piston-cylinder assemblies.

14. Apparatus, for feeding continuous pliable material, of variable elastic modulus, with a constant elongation, substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

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COMPLETE SPECIFICATION

3 SHEETS

*This drawing is a reproduction of
the Original on a reduced scale
Sheet 2*

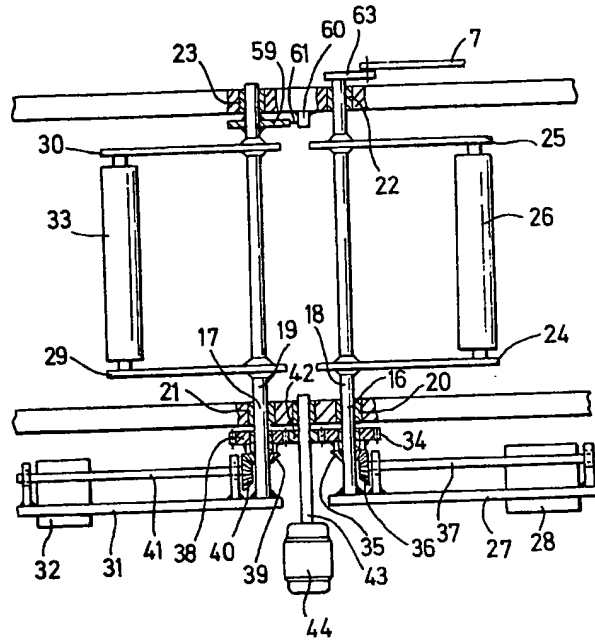


FIG. 2.

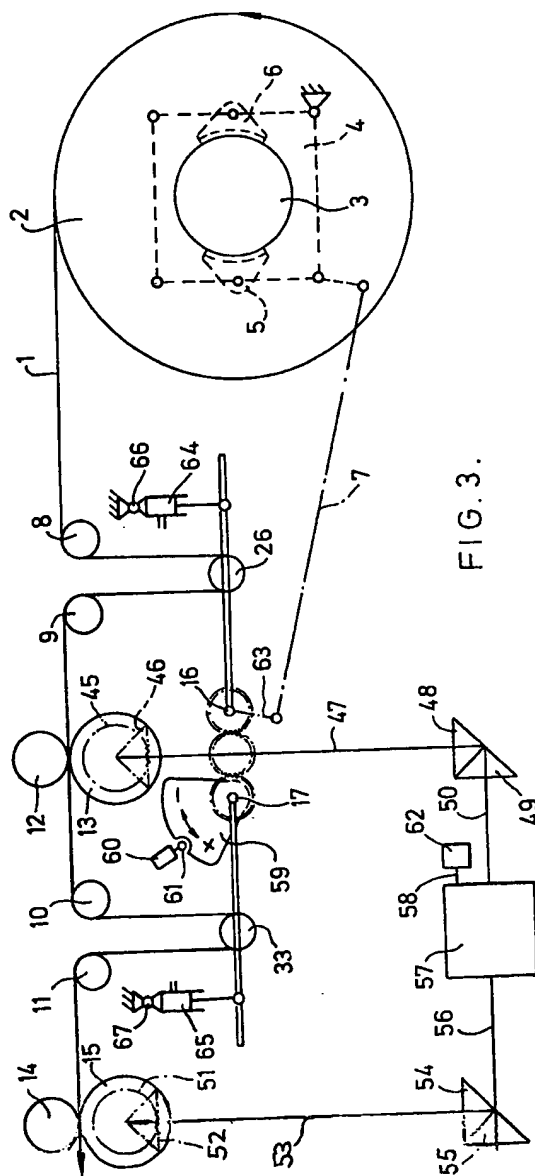


FIG. 3.